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ALUMINUM COMPANY OF AMERICA,
Alcoa Research Laboratories
Chemical Metallurgy Division
New Kensington, Pa.

(NASA CR-55851)

INVESTIGATION OF THE STRESS-CORROSION CRACKING OF HIGH-STRENGTH ALUMINUM ALLOYS

(NASA Contract ~~Number~~ - NAS 8-5340)
Control Number - TP3-85210 and S1 (1f)
CPB 02-1094-63

Second Quarterly Report,
(~~Period of~~ August 1 ~~to~~ October 31, [1963] ~~Inclusive~~)

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TABLE OF CONTENTS

ALUMINUM COMPANY OF AMERICA
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SYNOPSIS: 16734 A

All of the transverse 0.125" diameter tension bars have now been exposed to 3.5% NaCl alternate immersion and specimens for atmospheric sites have all been stressed and are currently being framed for exposure.

Ten of the fourteen surface treatments have been applied and alternate immersion tests initiated on the .500" diameter tension bars and ring specimens of those ten systems. Specimens intended to evaluate on intentionally damaged coating have been submitted for machining of a peripheral score mark. Framing operations have been started on specimens intended for atmospheric environments.

Control tests on specially aged items for the mechanism study indicate the desired range of susceptibility to stress-corrosion cracking for both 7075 and 2024 alloys. The specimens required for this program have been obtained. AUTHOR

WORK PROGRESS

Prior to Current Report Period

During the first quarter of the contract a total of 1077.5 man-hours were expended on: (a) the required literature survey and selection of 14 surface treatments for evaluation, (b) procurement of the various aluminum alloys and control tests on same, (c) specimen preparation, (d) design and construction of a test cell for the mechanism study and (e) initiation of altemate immersion tests on unprotected 0.125" diameter tensile bars.

Current Report Period (August 1 to October 31, 1963)

During the second quarter a total of 2034.75 man-hours were expended (613.25 in August, 598 in September and 823.5 in October) bring the total time expended to 3112.25 hours. The work performed was as follows:

(1) Inherent Resistance to Stress-Corrosion Cracking

The alternate immersion portion of this phase of the investigation had been initiated for certain specimens on July 2, 1963, and all of the originally scheduled specimens started test by October 18. The various specimens, stress levels employed, starting dates and data obtained thus far, (either time to failure or per cent reduction in tensile properties), are listed in the attached Table I. An analysis of these data will not be made until such time as all specimens have completed the 12-week test. This will occur during January, 1964, thereby permitting the analysis in the next quarterly report.

However, the performance of these specimens has been about as expected, with the exception of those of 2014-T651 and 7178-T651 alloys. Specimens from these two alloys have completed 84 days test at 25 ksi and 30 days at 30 ksi (approx. 50%Y.S.) without failure. Such a performance is above the usual resistance of the alloys. Consequently it has been decided to obtain six additional specimens of each alloy and expose them at 75, 50 and 25% Y.S. to verify the resistance to stress-corrosion of these two items.

The specimens scheduled for atmospheric exposures have been stressed and the stressing fixtures painted to prevent electrochemical action between the fixtures and specimens. These specimens are currently being mounted on wooden frames and will be shipped to the exposure sites during the month.

(2) Evaluation of Protective Treatments

At the time of writing, ten of the fourteen protective systems have been completed on both the 1/2" diameter tensile bars and 2-1/4" diameter ring specimens. The specimens intended for the alternate immersion environment were exposed as a system was completed, but with all specimens of the given system being exposed simultaneously. The starting dates and failures that have occurred are listed in the attached Table II. The data are, of course, too preliminary to be conclusive but thus far failures have been confined to the bare control specimens and the following four protective systems:

System No.	Treatment
5	Alumilite 205
6	Alumilite 226
7	Alodine 1200 + Zinc Chromate Primer
13	Zinc-Rich Paint

Systems 5, 6 and 7 had been included in the investigation primarily as controls because they are frequently used standard coatings. It was not expected that any of them would prevent stress-corrosion cracking, nevertheless, the results obtained on the two Alumilite coatings were somewhat surprising.

From the data in Table II, it is obvious that Alumilite 226 offered no substantial protection and even appears to have accelerated failure, except for alloy 7079-T751. These thick coatings grow primarily outwards from the surface during their formation but do not readily form around a corner. Consequently, the coatings may be thin of the outer corners of the ring and at the corners formed by the ring and plug. The geometry of the specimens might, therefore, be concentrating corrosive attack at the most critical location as regards inception of a stress-corrosion crack.

On the other hand, the Alumilite 205 is providing some protection except for alloy 7079-T651, in which case it might even be deleterious. Not only did the five coated specimens fail immediately in the alternate immersion test, but two of the thirty specimens of this system failed during the sealing phase of the Alumilite 205 process. Two additional stressed 7079-T651 specimens were submitted to the Finishes Division and only put through the sealing treatment, but for a prolonged time. No failures occurred; however, when the specimens were subsequently given the standard R3 prepatory etch and re-exposed to the sealing bath, failures did occur. This would indicate that the actual anodizing step was not required for accelerated failure, but that the pre-etch and sealing treatment were contributory.

These findings on both Alumilite systems will be further investigated to determine if they can be considered as representative of all anodized parts or whether they were influenced by the particular test conditions employed.

The Zinc-Chromate primer (System 7) appears to offer only limited protection in the alternate immersion environment. These specimens are being exposed in a separate tank compartment, because the Chromate tends to dissolve into the salt solution.

Only two failures have occurred for the Zinc-rich paint system and it is still too early to reliably judge the merits of this system.

The effectiveness of the various systems to prevent general corrosion will be determined by comparing the final tensile properties of the corroded 1/2" diameter bars with those obtained on as-machined controls (see Table III).

The specimens intended for atmospheric environments are being framed for exposure but shipment will be held, pending completion of the last four systems.

The specimens to be exposed to atmospheres with an intentionally damaged coating have been submitted to the

Machine Shop for scoring with a turning tool. A peripheral score mark is to be made in the ring along the centerline of the 0.500" width. The depth of the score is to be through the protective coating and 2 mils ± 1 mil into the underlying aluminum ring. In the case of the shot-peened specimens the score will, of course, be only 2 mils in depth.

As mentioned in the September monthly report, it was decided that the metallizing treatment must be a three-pass coating to insure complete coverage with no holidays. Originally a two-pass coating had been contemplated and this extra step necessitated increasing the coating thickness tolerances from the original 3 to 4 mils to the 5-7 mils listed in Table II.

One final point concerning preparation of the ring specimens which requires clarification is the fact that stressing procedures for the metallized (Systems 3 and 15) and peened (Systems 2 and 14) specimens differed slightly from those of the remaining 11 systems. For the 11 systems, the required interferences were calculated, the specimens stressed, and all surface treatments performed on stressed specimens. However, it was brought to our attention that the shot peening operation and the grit blasting required to prepare the surface for metallizing would produce peripheral metal movement causing growth in the ring ID, thereby reducing the interference and the resultant applied stress. In order to assess the magnitude of this change in I.D. a small pilot test was made. Three rings of 7079-T651 alloy were stressed to 75%Y.S., then unloaded and the change in I.D., due to insertion and removal of the plug, determined. (This was necessary as 75%Y.S. slightly exceeds the porportional limit and causes some permanent set.) Triplicate stressed rings were then submitted for peening and grit blasting after which they were unloaded and the change in I.D. determined. Average measurement indicated that shot peening caused an increase in the I.D. of approximately .002" over and above that attributable to insertion of the plug, while grit blasting caused an increase of .001". Interferences for the alloys being investigated ranged from 7 to 13.5 mils with a typical value (that of 7079-T651) being about 12 mils. Consequently it was felt that the change in I.D. was too great to be ignored and the following corrected actions were taken:

A - Metallizing - It was desired that both the ring and plug be metallized to prevent excessive consumption of the 7072 alloy metallized coating by a large cathodic bare plug. This meant that the specimens had to be stressed prior to grit blasting so that both ring and plug could be prepared for metallizing. Therefore these specimens were slightly overstressed by increasing the calculated interference by .001" to compensate for the expected growth in ring I.D. during grit blasting.

B- Shot Peening - The ring specimens were peened in an unstressed condition, the ID determined after peening and the required interference calculated. As a result, these (#2 and 14) were the only systems where the surface treatment was performed prior to stressing. This approach was used rather than the one used for metallized specimens for the following reasons:

1 - .002" was felt to be an excessive amount to overstress the specimens as it would cause too much permanent set.

2 - the certainty of achieving the desired stress level is greater by this method.

3 - shot peening is more effective on a stressed specimen and results in a greater magnitude of residual compressive stresses than it does on an unstressed specimen. Therefore the resistance to stress-corrosion cracking of specimens peened unstressed provides a more conservative appraisal of the peening treatment. Any improvement noted for the peened specimens in this investigation would have only been enhanced had the specimens been peened in a stressed condition.

(3) Mechanism Study

As a result of heavy work loads, the machining of the torsion specimens was delayed. However, the specimens on order and the finish machined grip holders have just been received (November 8) and preliminary test runs will be initiated shortly.

This phase of the investigation cannot be outlined in detail because of its highly exploratory nature. However, the total number of specimens initially obtained and the seven temper conditions being evaluated are listed in the attached Table IV. The supplementary data included (solution potentials and electrical conductivities) indicate that a range of susceptibility to stress-corrosion cracking should be represented, as desired. This will be verified by exposure of 1/8" diameter transverse tensile bars to 3.5% NaCl alternate immersion.

FUTURE WORK

Overall Plan

The attached Figure 1 represents an estimated program for the remainder of the work. Baring any unforeseen problems, all exposure tests should be started on or before the indicated dates.

Next Report Period (Nov. 1 to Nov. 30, 1963)

(A) Inherent Resistance to Stress-Corrosion Cracking

1 - complete framing operations and ship specimens for atmospheric exposure. The New Kensington specimens should be in test by November 15 and the Point Judith and Point Comfort specimens shipped by November 22.

(B) - Evaluation of Protective Treatments

(1) - complete application of Systems 11, 12, 14 and 15 and expose these systems to alternate immersion.

(2) - machine score marks on specimens to evaluate intentionally damaged coatings.

(3) - continue framing of specimens intended for atmospheric exposures.

(C) - Mechanism Study

(1) - determine original tensile properties

(2) - initiate torsion - corrosion tests

(3) obtain specimens for alternate immersion check tests.

TABLE I

ORIGINAL TENSILE PROPERTIES AND STRESS CORROSION DATA ON TRANSVERSE 1/8" DIA. BARS

Alloy & Temper	ARL S-No.	Average Original Transverse Properties T.S. (ksi)	Y.S. (ksi)	El. (%)	3.5% NaCl - Alternate Immersion: Unstressed: Dash No.	In Date (1963)	Exposure (Weeks)	% Loss T.S.	% Loss El.	Stressed - To Failure or 12 Weeks: Dash No.	In Date (1963)	Stress (ksi)	Days To Fail	% Loss T.S.	% Loss El.
2014-T651	302309	69.7	61.0	6.3	T4	7-30	1	9	68	T17	10-3	30			
					T5	"	2	8	68	T18	"	"			
					T6	"	4	15	68	T15	7-30	25	OK 84	28	84
					T7	"	8	22	52	T16	"	"	OK 84	32	100
					T8	"	12	21	68	T13	"	20	OK 84	26	68
										T14	"	"	OK 84	37	100
										T11	"	15	OK 84	23	68
										T12	"	"	OK 84	20	68
										T9	"	10	OK 84	20	68
										T10	"	"	OK 84	20	68
2024-T351	302210	63.3	40.8	15.3	T4	7-2	1	39	74	T15	7-2	25	3	-	-
					T5	"	2	44	74	T16	"	"	1	-	-
					T6	"	4	56	87	T13	"	20	3	-	-
					T7	"	8	55	87	T14	"	"	2	-	-
					T8	"	12	56	87	T11	"	15	5	-	-
										T12	"	"	4	-	-
										T9	"	10	5	-	-
										T10	"	"	18	-	-
										T17	7-30	"	73	-	-
										T18	"	"	73	-	-
2024-T851	302211	64.5	58.4	6.0	T4	7-2	1	6	67	T9	7-2	44	OK 84	12	33
					T5	"	2	8	50	T10	"	"	"	12	33
					T6	"	4	9	33	T11	"	"	"	14	33
					T7	"	8	15	67	T12	10-3	"			
					T8	"	12	19	50	T13	"	"			
2219-T62	302482	60.0	40.8	6.0	T4	7-19	1			T9	7-19	31	OK 84		
					T5	"	2			T10	"	"	OK 84		
					T6	"	4			T11	"	"	OK 84		
					T7	"	8			T12	10-18	"			
					T8	"	12			T13	10-18	"			
2219-T851	302307	63.9	46.7	6.7	T4	7-30	1	8	40	T9	7-30	35	OK 84	19	25
					T5	"	2	12	40	T10	"	"	OK 84	20	40
					T6	"	4	22	40	T11	"	"	OK 84	16	40
					T7	"	8	19	40	T12	10-3	"			
					T8	"	12	29	55	T13	"	"			

(CON'T)

TABLE I (CON'T)

Alloy & Temper	ARL S-No.	Average Original Transverse Properties T.S. (ksi)	Y.S. (ksi)	El. (%)	3.5% NaCl - Alternate Immersion: Unstressed Dash No.	In Date (1963)	Exposure (Weeks)	% Loss T.S.	El.	Stressed - To Failure or 12 Weeks Dash No.	In Date (1963)	Stress (ksi)	Days To Fail	% Loss T.S.	El.
2219-T87	302353	65.9	52.5	9.7	T4	7-31	1	11	59	T9	7-31	39	OK 84	24	79
					T5	"	2	15	59	T10	"	"	"	26	79
					T6	"	4	19	59	T11	"	"	"	23	79
					T7	"	8	19	59	T12	10-3	"			
					T8	"	12	23	79	T13	"	"			
X7006-T651	302507	61.6	52.6	9.5	T4	8-15	1			T9	8-15	40	34	-	-
					T5	"	2			T10	"	"	25	-	-
					T6	"	4			T15	10-18	35			
					T7	"	8			T16	"	"			
					T8	"	12			T17	"	30			
										T18	"	"			
										T11	8-15	26			
										T12	"	"			
										T13	"	13			
										T14	"	"			
7079-T651	302354	77.3	66.8	8.0	T4	7-30	1	5	25	T18	10-3	50	21	-	-
					T5	"	2	3	50	T9	10-18	"	15	-	-
					T6	"	4	7	50	T17	10-3	33			
					T7	"	8	16	75	T10	10-18	"			
					T8	"	12	8	75	T15	7-30	25	OK 84	14	75
										T16	"	"	"	11	75
										T13	"	20	"	9	62
										T14	"	"	"	13	62
										T11	"	15	"	9	75
										T12	"	"	"	11	62
7075-T651	302212	82.9	70.4	8.7	T4	7-2	1	10	66	T15	7-2	25	4	-	-
					T5	"	2	11	66	T16	"	"	4	-	-
					T6	"	4	15	77	T17	10-3	22.5	37	-	-
					T7	"	8	15	77	T18	"	"			
					T8	"	12	17	77	T13	7-2	20	27	-	-
										T14	"	"	OK 84	33	77
										T11	"	15	"	16	66
										T12	"	"	"	31	77
										T9	"	10	"	14	66
										T10	"	"	"	13	77
7075-T7351	302599	70.1	59.2	8.7	T4	8-15	1			T12	10-3	44			
					T5	"	2			T13	"	"			
					T6	"	4			T9	8-15	42			
					T7	"	8			T10	"	"			
					T8	"	12			T11	"	"			

(CON'T)

TABLE I (CON'T)

		Average Original Transverse Properties			3.5% NaCl - Alternate Immersion										
					Unstressed					Stressed - To Failure or 12 Weeks					
								% Loss						% Loss	
Alloy & Temper	ARL S-No.	T.S. (ksi)	Y.S. (ksi)	El. (%)	Dash No.	In Date (1963)	Exposure (Weeks)	T.S.	El.	Dash No.	In Date (1963)	Stress (ksi)	Days To Fail	T.S.	El.
7178-T651	302308	83.0	73.3	6.0	T4	7-30	1	11	67	T17	10-3	30			
					T5	"	2	15	100	T18	"	"			
					T6	"	4	17	67	T15	7-30	25	OK 84	41	67
					T7	"	8	19	67	T16	"	"	"	28	83
					T8	"	12	16	67	T13	"	20	"	15	67
										T14	"	"	"	18	67
										T11	"	15	"	16	67
										T12	"	"	"	18	50
										T9	"	10	"	16	67
										T10	"	"	"	17	67

Note: A blank spot in the table means either that the specimen has not as yet been exposed or else that the particular data has not as yet been obtained.

TABLE II

PROTECTIVE SURFACE TREATMENTS TO BE EVALUATED

System No.	System
1	As Machined - control
2	Shot peened
3	Metallized with 7072 aluminum alloy (three pass system with average thickness of 5 mil and maximum of 7 mils).
4	Zinc electroplate (3 to 4 mil).
5	Alumilite 205 (0.2 mil)
6	Modified Alumilite 226 (2 mil) (not applicable for 2219 alloy)
7	Alodine 1200 plus Zinc Chromate Primer (0.5 mil)
8	Alodine 1200 plus Epoxy-Polyamide (2 mil).
9	Alodine 1200 plus Strontium Chromate Epoxy Primer (1 mil) plus Epoxy-Polyamide (2 mil).
10	Alodine 1200 plus Strontium Chromate Epoxy Primer (1 mil) plus Epoxy-Polyamide Vehicle with added Aluminum pigment (1 mil) plus Epoxy-Polyamide (2 mil).
11	Alodine 1200 plus Polyurethane Pigmented with Titanium Dioxide (2 mil)
12	Alodine 1200 plus Strontium Chromate Epoxy Primer (1 mil) plus Polyurethane Pigmented with Titanium Dioxide (2 mil)
13	Zinc-rich paint (Epoxy-Polyamide Pigmented with Zinc)(3 mil)
14	Shot peened plus Alodine 1200 plus Strontium Chromate Epoxy Primer (1 mil) plus Epoxy-Polyamide (2 mil).
15	Metallized with 7072 aluminum alloy (three pass system with average thickness of 5 mil and maximum of 7 mil) plus Alodine 1200 plus Strontium Chromate Epoxy Primer (1 mil) plus Epoxy-Polyamide (2 mil).

TABLE II (con't.)

INVESTIGATION OF THE STRESS-CORROSION CRACKING OF HIGH STRENGTH ALUMINUM ALLOYS
EXPOSURE: 3-1/2% NaCl ALT. IMMERSION (1/2" DIA. UNSTR. TENSILE BARS AND 2-1/4" O.D. RINGS STR. 75% Y.S.)

	Starting Date	10-23-63			11-7-63			10-11-63														
		System #9			System #10			System #11			System #12			System #13			System #14			System #15		
		% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.
S. No.	Alloy	I.S.	El.	# - Days	I.S.	El.	#-Days	I.S.	El.	# - Days	I.S.	El.	# - Days	I.S.	mEl.	# - Days	I.S.	El.	# - Days	I.S.	El.	# - Days
302309	2014-T651	—	—	9R1-	—	—	10R1-	—	—	11R1-	—	—	12R1-	—	—	13R1-	—	—	14R1-	—	—	15R1-
				9R2-			1CR2-			11R2-			12R2-			13R2-			14R2-			15R2-
				9R3-			10R3-			11R3-			12R3-			13R3-			14R3-			15R3-
				9R4-			10R4-			11R4-			12R4-			13R4-			14R4-			15R4-
				9R5-			10R5-			11R5-			12R5-			13R5-			14R5-			15R5-
302354	7079-T651	—	—	9R1-	—	—	10R1-	—	—	11R1-	—	—	12R1-	—	—	13R1-	—	—	14R1-	—	—	15R1-
				9R2-			10R2-			11R2-			12R2-			13R2-27			14R2-			15R2-
				9R3-			10R3-			11R3-			12R3-			13R3-			14R3-			15R3-
				9R4-			10R4-			11R4-			12R4-			13R4-21			14R4-			15R4-
				9R5-			10R5-			11R5-			12R5-			13R5-			14R5-			15R5-
302210	2024-T351	—	—	9R1-	—	—	10R1-	—	—	11R1-	—	—	12R1-	—	—	13R1-	—	—	14R1-	—	—	15R1-
				9R2-			10R2-			11R2-			12R2-			13R2-			14R2-			15R2-
				9R3-			10R3-			11R3-			12R3-			13R3-			14R3-			15R3-
				9R4-			10R4-			11R4-			12R4-			13R4-			14R4-			15R4-
				9R5-			10R5-			11R5-			12R5-			13R5-			14R5-			15R5-
302308	7178-T651	—	—	9R1-	—	—	10R1-	—	—	11R1-	—	—	12R1-	—	—	13R1-	—	—	14R1-	—	—	15R1-
				9R2-			10R2-			11R2-			12R2-			13R2-			14R2-			15R2-
				9R3-			10R3-			11R3-			12R3-			13R3-			14R3-			15R3-
				9R4-			10R4-			11R4-			12R4-			13R4-			14R4-			15R4-
				9R5-			10R5-			11R5-			12R5-			13R5-			14R5-			15R5-
302353-	2219-T87	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.
302599	7075-T73	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.

Notes: (1) In each case, tensile losses are average of triplicate 1/2" dia. longitudinal tensile bars.

(2) Stress corrosion specimens are 2-1/4" O.D. x 1/8" wall x 1/2" wide O-rings stressed in hoop tension to 75% trans. Y.S.

(3) Starting dates apply both to bars and rings.

TABLE II (con't.)

INVESTIGATION OF THE STRESS-CORROSION CRACKING OF HIGH STRENGTH ALUMINUM ALLOYS

EXPOSURE: 3-1/2% NaCl ALT. IMMERSION (1/2" DIA. UNSTR. TENSILE BARS AND 2-1/4" O.D. RINGS STR. 75% Y.S.)

	Starting Date }	10-11-63 System #1 (Bare)			11-1-63 System #2			11-11-63 System #3			10-22-63 System #4			10-11-63 System #5			10-27-63 System #6			10-11-63 System #7			10-17-63 System #8		
		% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	%Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.	% Loss		S.C.C.
S. No.	Alloy	I.S.	El.	# - Days	I.S.	El.	# - Days	I.S.	El.	# - Days	I.S.	El.	#-Days	I.S.	El.	#-Days	I.S.	El.	#-Days	I.S.	El.	#-Days	I.S.	El.	#-Days
302309	2014-T651	—	—	1R1- 6 1R2- 3 1R3- 4 1R4- 6 1R5- 4	—	—	2R1- 2R2- 2R3- 2R4- 2R5-	—	—	3R1- 3R2- 3R3- 3R4- 3R5-	—	—	4R1- 4R2- 4R3- 4R4- 4R5-	—	—	5R1- 5R2- 5R3- 5R4- 5R5-	—	—	6R1-2 6R2-2 6R3-2 6R4-2 6R5-2	—	—	7R1-11 7R2-15 7R3-19 7R4-18 7R5-18	—	—	8R1- 8R2- 8R3- 8R4- 8R5-
302354	7079-T651	—	—	1R1-14 1R2-16 1R3-17 1R4-14 1R5-10	—	—	2R1- 2R2- 2R3- 2R4- 2R5-	—	—	3R1- 3R2- 3R3- 3R4- 3R5-	—	—	4R1- 4R2- 4R3- 4R4- 4R5-	—	—	5R1-1 5R2-1 5R3-1 5R4-1 5R5-1	—	—	6R1- 6R2- 6R3-9 6R4- 6R5-	—	—	7R1- 7R2- 7R3-4 7R4- 7R5-	—	—	8R1- 8R2- 8R3- 8R4- 8R5-
302210	2024-T351	—	—	1R1-16 1R2-23 1R3-13 1R4-14 1R5-21	—	—	2R1- 2R2- 2R3- 2R4- 2R5-	—	—	3R1- 3R2- 3R3- 3R4- 3R5-	—	—	4R1- 4R2- 4R3- 4R4- 4R5-	—	—	5R1- 5R2- 5R3- 5R4- 19 5R5-	—	—	6R1-7 6R2-7 6R3-7 6R4-7 6R5-7	—	—	7R1-23 7R2-30 7R3- 7R4- 7R5-21	—	—	8R1- 8R2- 8R3- 8R4- 8R5-
302308	7178-T651	—	—	1R1-17 1R2-15 1R3-16 1R4-17 1R5-17	—	—	2R1- 2R2- 2R3- 2R4- 2R5-	—	—	3R1- 3R2- 3R3- 3R4- 3R5-	—	—	4R1- 4R2- 4R3- 4R4- 4R5-	—	—	5R1- 5R2- 5R3- 5R4- 5R5-	—	—	6R1-3 6R2-6 6R3-3 6R4-8 6R5-6	—	—	7R1- 7R2- 7R3- 7R4- 7R5-	—	—	8R1- 8R2- 8R3- 8R4- 8R5-
302353	2219-T87	—	—	1R1- 1R2- 1R3- 1R4- 1R5-	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.
302599	7075-T73	—	—	1R1- 1R2- 1R3- 1R4- 1R5-	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.	—	—	N. T.

Notes: (1) In each case, tensile losses are average of triplicate 1/2" dia. longitudinal tensile bars.

(2) Stress corrosion specimens are 2-1/4" O.D. x 1/8" wall x 1/2" wide O-Rings stressed in hoop tension to 75% trans. Y.S.

(3) Starting dates apply both to bars and rings.

TABLE III

ORIGINAL TENSILE PROPERTIES (*)
LONGITUDINAL 1/2" DIA. BARS

Alloy & Temper	ARL S-No.	Dash No.	T.S. (ksi)	Y.S. (ksi)	El. (% In 4D)	Reduction Of Area (%)
2014-T651	302309	L1	67.6	62.3	10.5	27
		L2	69.1	64.0	13.0	30
		L3	70.0	65.1	12.5	29
		AVG.	68.9	63.8	12.0	28.7
2024-T351	302310	L1	65.3	48.7	22.0	28
		L2	65.8	48.6	22.0	29
		L3	65.4	48.6	21.5	30
		AVG.	65.5	48.6	21.8	29
2219-T87	302353	L1	68.1	56.1	12.5	28
		L2	67.1	55.0	13.0	29
		L3	67.5	55.3	12.5	29
		AVG.	67.6	55.5	12.7	28.7
7075-T7351	302599	L1	76.9	68.5	14.0	38
		L2	73.9	65.5	14.5	38
		L3	76.5	67.6	13.5	37
		AVG.	75.8	67.2	14.0	38
7079-T651	302354	L1	79.0	72.7	13.0	26
		L2	78.1	71.8	12.5	25
		L3	78.3	72.0	13.0	26
		AVG.	78.5	72.2	12.8	26.7
7178-T651	302308	L1	86.6	80.3	12.5	23
		L2	85.8	79.6	13.0	24
		L3	85.9	79.8	13.0	23
		AVG.	86.1	79.9	12.8	23.3

NOTES: (*) Subsequently to be compared with data obtained on specimens exposed according to the schedule in Table II for determination of per cent loss in tensile strength and elongation due to corrosion.

TABLE IV

ITEMS BEING EVALUATED IN MECHANISM STUDY

S. No.	Alloy	Temper	Electrical Conductivity %IACS	Solution Potential -MV (1)	Tensile Property Tests		Torsion Specimens
					Longitudinal	Transverse	Number
302210	2024	-T351	31.8	694	N.C. (2)	N.C. (2)	25
302520	2024	-T351 Aged 4 hrs. at 375°F	36.5	775	N.C.	N.C.	20
302211	2024	-T851	40.6	819	N.C.	N.C.	20
302521	2024	-T851 Aged 4 hrs. at 375°F	41.0	819	N.C.	N.C.	20
302212	7075	-T651	32.0	828	N,C.	N.C.	25
302522	7075	-T651 Aged 2 hrs. at 350°F	36.6	808	N.C.	N.C.	20
302523	7075	-T651 Aged 8 hrs. at 350°F	39.7	790	N.C.	N.C.	20

Notes: (1) Average steady value referred to 0.1N Calomel cell at 25°C.
Alloy 2024 potentials obtained in a NaCl-H_2O_2 solution.
Alloy 7075 potentials obtained in an acidified NaCl solution.

(2) In progress - not completed.

ESTIMATED PROGRAM SCHEDULE

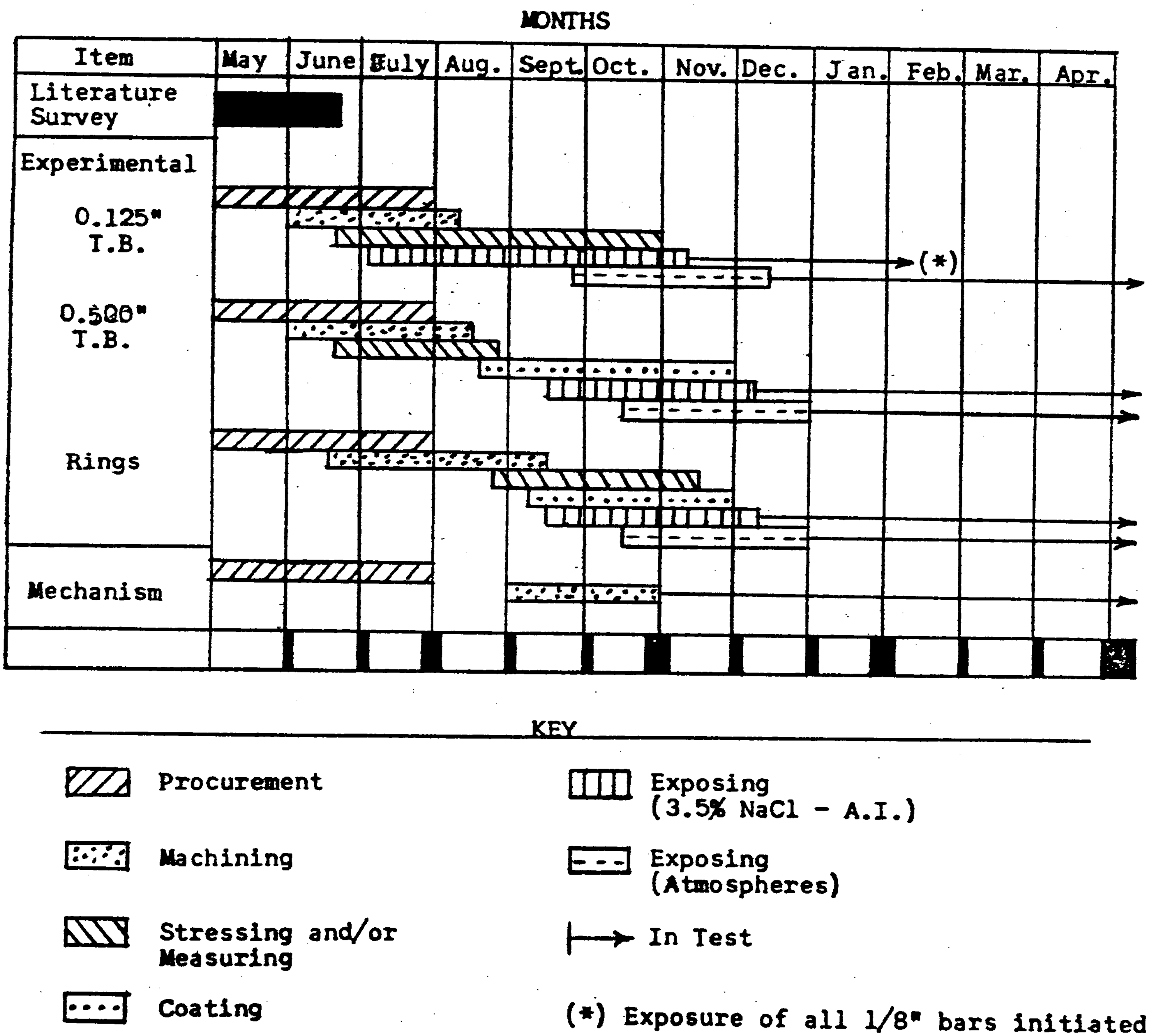

FIGURE 1